

Wisconsin Highway Research Program

Evaluation of Wisconsin Department of Transportation QMP (Quality Management Program) Activities and Impacts on Pavement Performance

Wisconsin Highway Research Program
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**Temple University
University of Wisconsin-Milwaukee
The Transtec Group
September 22, 2014**

Summary Page

Project Title: Evaluation of Wisconsin Department of Transportation QMP (Quality Management Program) Activities and Impacts on Pavement Performance

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Proposed Contract Period: 24 Months

Total Contract Amount: \$100,000

Indirect Cost Portion at 12 %

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Research Plan

Background

The Wisconsin Department of Transportation (WisDOT) developed their Hot Mix Asphalt (HMA) Quality Management Program (QMP) in the early 1990's. Endorsed by the Federal Highway Administration (FHWA), QMP is considered a best construction practice to help ensure that the agency is receiving quality construction materials that are being produced by a contractor for an agency project. The development of the QMP specification involved identification of key asphalt mixture parameters and how they relate to long term pavement performance, selection and potential modification of national standardized material testing methods and procedures, establishing testing frequencies and test method sample evaluation thresholds, corrective action guidance and pay adjustment factors. Additionally, the QMP specification required the development of the agency's quality control (QC) oversight program consisting of quality assurance (QA) and quality verification (QV) as well as a WisDOT sponsored QMP technician training program which became known as the Highway Technician Certification Program (HTCP). Full implementation of the HMA QMP specification, defined as being normally applied to all projects that utilized HMA pavement material, was accelerated and in place by the mid-1990's.

Since the implementation of the HMA QMP specification, the specification has seen multiple revisions in response to specification interpretation and application requests; but, the key HMA mixture parameters (aggregate gradation, asphalt content, air voids, voids in the mineral aggregate) and in place pavement density have remained as the HMA QMP quality measures. As the specification approaches its twentieth anniversary, WisDOT is in a position to quantifiably evaluate the effectiveness of the HMA QMP specification. WisDOT has a wealth of historical pavement management, project design, mixture design and QMP data that can be geographically related together, queried and analyzed

Objectives

The main objective of this study is to evaluate the current QMP, its current measures, required frequencies and subsequent trends for impacts on ultimate pavement performance. The following questions are to be answered by this study:

- Is WisDOT measuring the most critical product parameters in order to affect performance?
- Do current WisDOT QMP specification requirements motivate product adjustments that enhance pavement performance?
- Is the current WisDOT QMP system maximizing its value?

Additionally the study will assess the effectiveness of a recent specification change that was intended to increase the amount of asphaltic binder in the mixture in an effort to enhance the HMA pavement performance.

The research team has identified that the establishment of a systematic process of geographically relating the multiple WisDOT "pavement" databases together is crucial to the development of the study's analysis database as well as future studies that utilize data from multiple WisDOT "pavement" databases. The research team will fully document the systematic process of geographically relating the multiple WisDOT "pavement" databases that are used.

Research Approach

The research team realized the complexity of this project in terms of connecting the available sources of information and databases to field performance. Therefore, the research will utilize a layered approach in order to

meet the research objectives. This current HMA QMP practice as stated in Standard Specification 460.2.8 focuses on four mix properties: (1) Gradation, (2) Asphalt Content, (3) Air Content (lab and field), and (1) VMA

In order to understand the relationship between these properties and pavement performance, the research team will conduct a search in the available databases to characterize projects with respect to:

- 1- Degree of variability of each of the mix properties.
- 2- Applied payment penalty and the quantity impacted by the pay reduction.
- 3- Pavement structural design (Number of HMA layers, Layer thicknesses, NMAS, Base thickness, etc)
- 4- Rate of deterioration.

Once database analysis is conducted, the projects in the databases will be grouped such that an optimized selection of projects for field study is to be conducted. It is important to set some constraints to assure that the conclusions of this study are effective to the state of practice and focused on QMP rather than branching to other parameters given the scale of information available in the databases.

These constraints will be implemented to assure that the results of the database analysis and field testing are normalized against mix design and pavement structure. The purpose of deciding on two levels of asphalt content is to provide some indication of the effect of increasing the asphalt content on pavement performance. This is to investigate the validity of recent HMA Technical Team efforts in making specification changes to increase the asphalt content with the goal of improving performance.

The objective is to make sure that the observed pavement performance of the selected projects can be attributed to issues with construction quality as currently presented by the QMP. The remaining unknown for evaluation of pavement performance is isolating the effect of the subsequent layers. Therefore, the selected projects will undergo Falling Weight Deflectometer (FWD) testing to distinguish between failures due to HMA weakness or nonconforming quality, and that due to weakness in base course or subgrade.

Based on the scheme discussed above, four projects that represent different categories related to QMP variables in addition to a fifth control project meeting all quality indications will be selected. The details of the QMP data analysis and field projects selection and testing are included in the next section.

A flow chart of the project activities is illustrated in figure 1 at the end of this section.

Proposed Work Plan

Task 1. Literature Review

The literature review will focus on identifying similar efforts in improving QMP impact on the overall pavement industry. Detailed search will be conducted on the relationship between QMP and pavement long term performance. The details to be searched will cover:

- 1- Frequency of testing
- 2- Control limits
- 3- Properties included in the QMP
- 4- Influenced pavement performance

The findings of this task will provide guidance to the research team with respect to database analysis and selecting projects. The research team will also conduct a review of all state DOT specifications and study their QMP practice. Specifically, comparison of WisDOT to other states will be highlighted using NCHRP Synthesis 346, "State Construction Quality Assurance Programs: A Synthesis of Highway Practice" (Hughes 2005) and NCHRP 10-79 report, "Guidelines for Quality-Related Pay Adjustment Factors for Pavements" (Hughes et al. 2011). This

will help in identifying where Wisconsin DOT stands compared to the rest of the states. More importantly, it will provide a pool of practice approaches applied nationwide.

The review of published research studies and State specifications will allow the research team to cover both the state-of practice and state-of-art of this important issue. The preliminary literature search conducted for this proposal (Samuel and Young 2013) shows that the majority of state agencies implement QMPs comprised of: (1) Quality control, (2) Acceptance, (3) Independent assurance, (4) Correlation (correlating results from different labs to account for testing variability), and (5) Referee.

These components are similar to those implemented in Wisconsin. It is expected that the Quality Control test results, for example, vary from acceptance. On the other hand, it is impossible to expect 100% conformity of all testing. Furthermore, on a philosophical level, are these tests truly representatives of “quality”. These issues are the expected challenges to face the research team. It is important to acknowledge these challenges and design a work plan to navigate through these challenges to advance the knowledge base. Therefore, the literature search presents the first step towards handling these challenges by comparing Wisconsin practice to the rest of the country.

Task 2. Analyze Available Databases of Past Flexible Pavement

Based on Task 1, the research team will conduct a comprehensive search of information/data on the available databases. This search will focus on projects that are constructed after the implementation of SuperPave™ in Wisconsin. For efficient use of the available resources for this project, the search will be limited to projects meeting the following criteria:

- 1- Traffic level of E-3 or higher. This to guarantee that the pavement underwent sufficient loading such that field distresses may be attributed to traffic.
- 2- No SMA projects.
- 3- Projects with flexible base (no PCC overlays).
- 4- No projects with added HMA overlay or surface treatment.
- 5- Projects must have 5 to 10 years of service.

The purpose of setting the criteria above is to assure that the analysis of the compiled database is focused on typical HMA. Given the expected large amount of data available in the databases, establishing these limits will help avoid a common problem with similar projects. This problem is the establishment of correlations between sets of data although there is no apparent cause- and-effect relationship. In this case, the obtained correlations can be more harmful than useful. Therefore, these constraints will serve to control the database analysis process to minimize the presence of such scenario. The research team will maintain high level of awareness of the possibility of this issue throughout the execution of the study. The objective of this task is to thoroughly examine all available historical information/data in order to truly identify the available information, and the different controlling categories of the different projects available. Details of collecting the information/data through the search and through the field investigation are given in the following subtasks:

Subtask 2.1: Develop Database of Flexible Pavement Projects

In this subtask the research team will collect information from the different databases meeting the criteria mentioned above. Given the scattered information between the different databases containing project information, the research team will combine the data in a single database. Projects will then be divided between the following categories in order to evaluate general trends of QMP data versus recorded performance over the years of service. These categories are:

- 1- Projects with Neat asphalt binder;

- 2- Projects with Modified asphalt binder;
- 3- Projects with single lift/single NMAAS;
- 4- Projects with double lifts/two NMAAS;
- 5- Projects constructed before October 15th .

It is important to note that a given project can reside in one or more categories. The purpose of this categorization is to conduct analysis of the database information to screen any apparent specific trends for these categories. The goal is to highlight the potential influence of the project parameters beyond QMP on the recorded performance. A sensitivity analysis will be conducted to quantify, the overall level of variability in QMP data during construction, and typical distresses observed during the service life of these projects. This step will help focus the remaining tasks of the project on the category(s) that show more variability in QMP or higher trend of damage. This approach will also help the research team identify the obvious question of why these categories may exhibit variable levels of performance although the SuperPave mix design protocol, theoretically, is not dependent on these categories.

The category of projects constructed before October 15th is listed to isolate projects constructed during extended paving season. Although this is an important issue to investigate, but for this initial study, the research team prefer to minimize un-controlled variables to avoid misleading results due to interactions. Construction date/weather will be investigated at a future phase).

It is important to note that the research team plans to construct a database of all flexible pavement sections under department jurisdiction with detailed information concerning the pavement surface and underlying layer structure. This database will provide the basis for selecting a minimum of 5 existing pavements to evaluate the existing performance using detailed distress survey and non-destructive testing techniques. Projects will be identified in a coordinated effort with the TOC/POC.

Table 1 presents the source databases with a brief description of key data fields. The Meta Manager, PIF, Ride Report, and Quality databases will be merged by pavement Sequence Number to yield a single composite database for every flexible pavement segment constructed in Wisconsin under the jurisdiction of WisDOT. The research team will also require the use of Mix Design database available in excel workbook format.

Table 1. Databases for the Study

Source Database	Description
Meta Manager	This database compiles traffic, safety, and roadway data with forecasts of anticipated traffic levels. Key data fields in this data set applicable to the study include highway number, pavement sequence number (SEQNO), Reference Point (RP), termini of segment, pavement type, functional class, number of lanes, AADT, and percent trucks.
Pavement Inventory Files (PIF)	Descriptions and pavement distress data for each sequence number (SEQNO) are provided in the PIF database, including International Roughness Index (IRI), Pavement Condition Index (PCI), rutting depth, and individual pavement distress measurements (alligator cracking, edge raveling, etc.). This database also includes highway number, surface year, segment termini description, directional lane of measurement, date of measurement, region number, and county. Data from the PIF will provide a direct measure of flexible pavement performance over a flexible base.
New Construction (Ride) Reports	Attributes of projects constructed in a given year are detailed, including such fields as prime contractor, base type and/or preparation (DGBC, OGBC, milled, pulverized, rubblized, etc.), thickness asphalt layer placed, mixture design (SMA, Superpave ESAL series, etc.), lane-miles of paving, and project identification number. The paving year and highway number in this database will be merged with the SEQNO in the Meta Manager and PIF databases to develop a holistic database.
Highway Quality Management System	This database developed by Atwood Systems contains important data for QMP material properties. This database cannot be electronically linked to the databases above and will require manual extraction. The research team will coordinate with the TOC/POC to obtain electronic mix designs and QMP quality control data charts and moving averages to supplement this database.

Subtask 2.2: Analyze the Compiled Database

In an effort to select appropriate projects for field evaluation, the historical database created in Subtask 2.1 will be analyzed for identification of general trends that are related to project conditions. The objective of this subtask is to identify these trends such that they do not interfere with the detailed analysis of the selected field projects. Ultimately, the research team is trying to find the influence of the QMP data on the pavement performance independently of the project conditions. This subtask serves to enforce this independence.

This subtask will result in providing the needed guidelines for selecting projects from the appropriate categories listed in Subtask 2.1. For example, the database analysis will highlight if projects with neat binders accumulated more surface damage compared polymer modified binders. Similarly, this comparison will reveal general trends in QMP consistency for these two categories. The same approach will be used analyzing the database for all five categories. Although such comparisons are not specified as objectives of the research study, the research team needs to perform this step in order to select projects that show higher potential for damage as well as higher sensitivity to variation in QMP data. This will serve to continue the project tasks with more focus on the providing answers for the presented questions in the RFP.

Subtask 2.3: Identify Projects for Field Evaluation

Based on the detailed analysis of the database, a minimum of five field projects will be identified for the field evaluation. The expected selections will serve to evaluate the effect of QMP variability on the field performance and identify the measured property(s) within the QMP that may influence field performance. Although subtask 2.2 proposed a set of categories for the analysis to normalize the effect of the construction conditions on the final performance, one mix parameter still need to be evaluated with respect to its influence on the performance. This variable is the asphalt content. According to the RFP, this project is required to also “focus on the effectiveness of recent department supported HMA Technical Team efforts in making recent specification changes to increase the amount of asphaltic binder in mixtures with a goal of enhancing product performance”. Therefore, the

selected projects should provide some information on the effect of increasing asphalt content on performance. The selection methodology relies on recorded performance in the PIF database. The selected five projects are expected to meet the following conditions:

- Project 1: High Distress, High Asphalt Content, High Conformity (less variability in QMP data)
- Project 2: High Distress, Low Asphalt Content, High Conformity (less variability in QMP data)
- Project 3: High Distress, High Variability
- Project 4: Low Distress, High Variability
- Project 5: Low Distress, High Conformity (Control)

It is important to note that the asphalt content mentioned above refers to percent version binder used in the mix compared to total asphalt content. These combinations will serve to provide qualitative comparisons between the projects. It is important to not the variability in the QMP can be for any of the recorded properties (Density, Gradation, VMA, or Asphalt Content). The evaluation of the full database in subtask 2.2 will reveal the most variable among these properties and the associated damage. The purpose of deciding on two levels of asphalt content is to provide some indication of the effect of increasing the asphalt content on pavement performance. This is to investigate the validity of recent HMA Technical Team efforts in making specification changes to increase the asphalt content with the goal of improving performance. In addition, a quantitative evaluation as well as comparison between the different projects will be conducted. The details of these comparisons are explained in Task 3

Task 3. Conduct Field Evaluation of Selected Projects

For the selected five projects, full field evaluation will be conducted. The evaluation will include field visual distress survey as well as FWD testing

Subtask 3.1: Field Visual Distress Survey

For the field visual distress survey, One mile of the project length will be mapped. Analysis of the field distress will be conducted using the software PAVER™ and the pavement condition index (PCI) will be calculated according to the ASTM standard procedure. The outcome of this subtask will be presented as the intensity of the observed distresses as well as a full map of distress (cracks, raveling, rutting, etc.) throughout the project length. This map can then be compared to the QMP data and sampling stations to relate field performance against the database data. It is important to note that some of the distresses may not be materials related, but rather dependent on the pavement foundation (e.g., base course). In addition, the actual traffic volume may have exceeded that of the design causing premature failure. To isolate the effect of the pavement foundation on the observed distresses, FWD testing will be conducted. In addition, data obtained by the DOT regarding the traffic counts over the project service will be collected and compared to that of the design level of traffic.

Subtask 3.2: Falling Weight Deflectometer Testing

The selected pavements will be subjected to FWD testing. FWD tests will be conducted every 100 ft. staggered for the one mile of the project length mapped for distresses. Analyses will be conducted on the FWD test results to calculate the pavement layer moduli, pavement structural number, subgrade modulus, pavement layer deflection, etc. The staggered test points will help in developing a grid for the measured calculated values. The grid will be used to create a contour map of the results and compare it to the distress survey map. This comparison will provide the needed information to confirm if the observed distresses are due to HMA or pavement foundation.

Task 4. *Conduct Analysis of the Field Data and Compare to QMP Data*

In this task the field data collect will be compiled to analyze the selected pavement conditions. Damage due to weakness in pavement foundation will be removed from the pavement condition as illustrated in subtask 3.2. . The ultimate objective of this task is to overlap the distresses contour map with the available QMP data divided by project lots and sublots. This should immediately reveal the relationship between consistency in material quality and pavement performance. In addition, this approach will help isolate potential tested mix properties that show significant effect on the pavement performance. For example, this approach will help identify the effect of VMA consistency on pavement performance. It is important to note that this approach conducts the analysis within projects, not between projects. If the same observations are repeated for the majority of the selected five projects then a generalized conclusion may be suitable. On the other hand, if the trends within projects show variation, then analysis between projects will be conducted for further investigation.

The selection of the five projects with the conditions set in subtask 2.3 will guide the “between” projects analysis. As mentioned above, analysis between projects will highlight possible interactions between mix properties as reported by the QMP and pavement conditions. The following are possible scenarios for the comparisons illustrating the significance of the project selection criteria:

- Comparison between Project 1 (High asphalt content) against Project 2 (Low asphalt content) can obviously highlight the potential effect of increasing the asphalt content on field performance for the same level of conformity to QMP limits.
- Comparison of Projects 1 and 2 against Project 3 will provide insight on the effect of testing consistency for projects with high level of distress
- Comparison of Project 3 against Project 4 will provide insight on effect of QMP lack of consistency on observed distress. This comparison can potentially identify what mix properties tested as part of the QMP have higher potential for causing distress. For example, project 3 may not be consistent in field density, while Project 4 is not consistent in mix asphalt content. Yet Project 3 is showing higher level of distress compared to Project 4.
- Comparison of Project 5 (control) against other 4 projects will complement and validate the observations obtained. This is very important step due to the few number of projects under study for this research, given the limited resources available. More importantly, this validation process provides direction for future research projects tackling more specific objectives in order to facilitate the transition to performance-based mixture specification.

The aggregate structure as demonstrated by the VMA obtained from the mix design database will be used as an independent variable to evaluate the potential influence on performance. Finally, the ride quality of all projects will be analyzed as a dependent variable. Although the ride quality is not included in the project criteria, the available ride data will be considered to evaluate the changes in ride quality over the service life for the selected five projects. This approach will be followed to maintain a suitable number of field projects while providing a robust experimental design to optimize outcomes.

Task 5. *Isolate Components of the QMP Influencing Pavement Performance*

Based on Task 4, the different components of the QMP can be (qualitatively) attributed to pavement performance. This task will provide the needed answers for questions presented in the RFP:

- Is WisDOT measuring the most critical product parameters in order to affect performance?
- Do current WisDOT QMP specification requirements motivate product adjustments that enhance pavement performance?

- Is the current WisDOT QMP system maximizing its value?

Trends of the effect of increasing the asphalt content can be illustrated. As part of the pavement performance, ride quality will be analyzed to illustrate its dependency on QMP components.

Task 6. Final Project Deliverables

A final report that documents the research scope and outcome will be submitted including documentation of the databases created as well as detailed analysis. A close-out presentation will be scheduled after submitting the draft final report to WHRP.

Anticipated Research Results

The results/findings of this research will help the department identify the need development of performance based specifications for HMA mix design and construction. The outcomes of this study (if approved by WisDOT) are expected to affect the WisDOT Specification SS460, Construction Materials Manual CM 8.15, and CM 8.36..

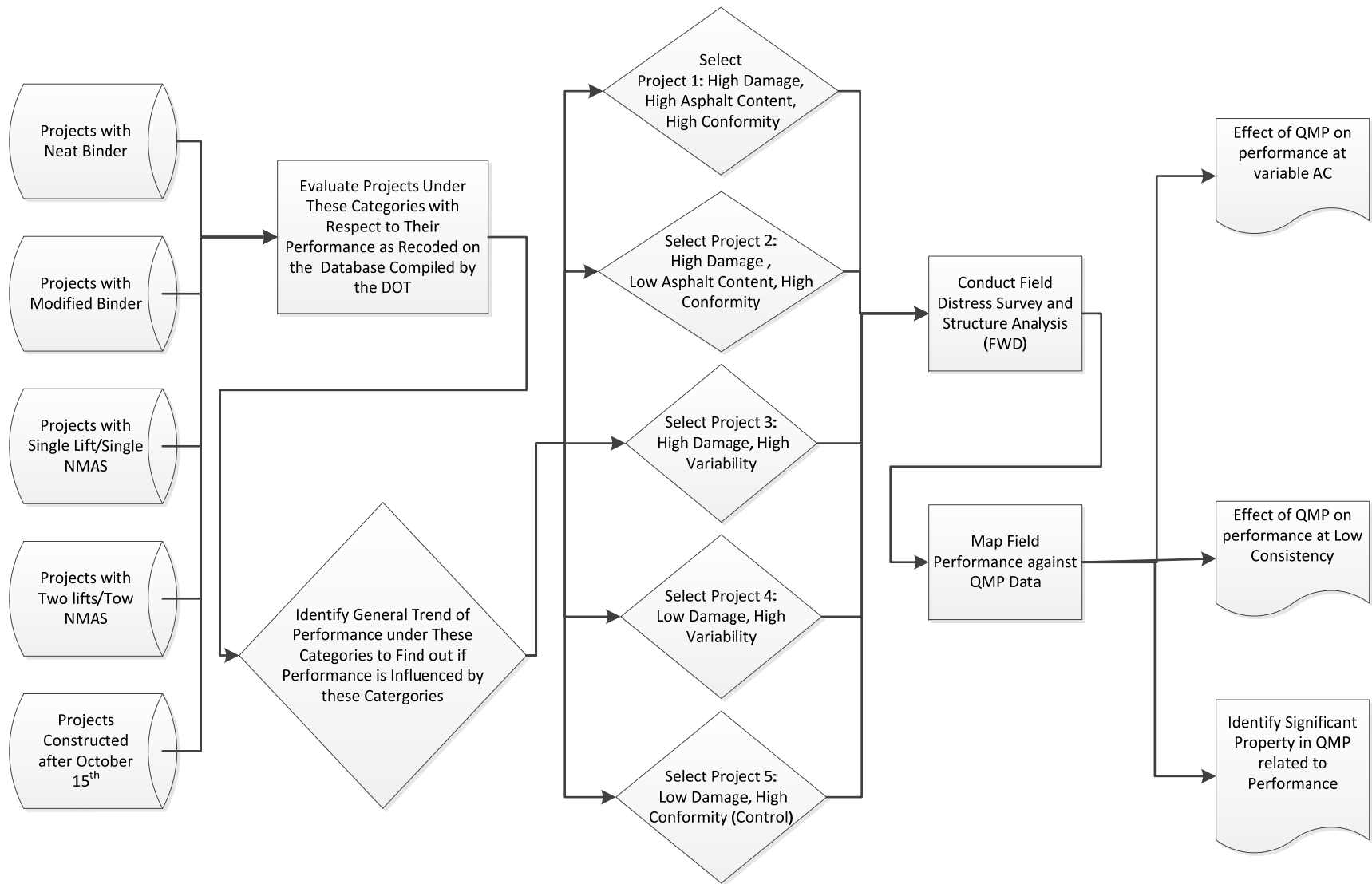


Figure 1 Flow Chart of the Project Activities

Time Requirements

Project duration of 24 month is set forth by the WHRP. The following time schedule assumes start date of October 1st 2014.

Task	2014	2015				2016		
	Oct-Dec	Jan - Mar	Apr-Jun	Jul-Sept	Oct-Dec	Jan - Mar	Apr-Jun	Jul-Sept
1								
2								
3								
4								
5								
6								*

* denotes final submittal after review comments are incorporated

Budget

INDIVIDUALS	TASKS						TOTAL HOURS
	1	2	3	4	5	6	
PI: Ahmed Faheem	20	75	100	45	80	50	370
Co-PI: Hani Titi	20	60	80	40	24	40	264
Consultant: Scot Schwandt	10	30	10	20	20	10	100
Consultant: Robert Schmitt	20	40	20	30	20	40	170
Hourly Students (Temple Univ.)	40	160	0	100	40	0	340
Students (UWM)	0	80	80	45	40	40	285
TOTALS	110	445	290	280	224	180	1529

BUDGET WORKSHEET

Evaluation of Wisconsin Department of Transportation QMP Activities and Impacts on Pavement Performance

Table 1 Work Effort by Task

INDIVIDUALS	TASKS						Total Salaries	Fringes	Total Salaries and Fringes
	1	2	3	4	5	6			
Principal Investigator: Ahmed Faheem	\$ 1,092	\$ 4,095	\$ 5,460	\$ 2,457	\$ 4,368	\$ 2,730	\$ 20,202	\$ 1,876	\$ 22,078
Hourly Students/Junior Staff	\$ 400	\$ 1,300	\$ -	\$ 1,000	\$ 400	\$ -	\$ 3,100		\$ 3,100
TOTALS	\$ 1,492	\$ 5,395	\$ 5,460	\$ 3,457	\$ 4,768	\$ 2,730	\$ 23,302	\$ 1,876	\$ 25,178

Table 2 Total Contract Summary by Fiscal Year

							Year 1*	Year 2	TOTALS
Total Faculty Salaries, Wages (From Table 1) - Ahmed Faheem	\$ 1,092	\$ 4,095	\$ 5,460	\$ 2,457	\$ 4,368	\$ 2,730	\$ 10,647	\$9,555	\$20,202
Total Student Salaries, Wages (From Table 1)	\$ 400	\$ 1,300	\$ -	\$ 1,000	\$ 400	\$ -	\$ 1,700	\$1,400	\$3,100
Fringes Faculty (Ahmed Faheem)	\$ 309	\$ 336	\$ 448	\$ 201	\$ 358	\$ 224	\$ 1,093	\$784	\$1,876
Fringes Students									
Sub-Contracts (Please list each subcontract seperately)									
Subcontractor 1 (Hani Titi)	\$ 1,700	\$ 7,100	\$ 8,800	\$ 4,525	\$ 3,040	\$ 4,400	\$ 14,667	\$ 14,898	\$ 29,565
Subcontractor 2 (Scot Schwandt)	\$ 1,000	\$ 3,000	\$ 1,000	\$ 2,000	\$ 2,000	\$ 1,000	\$ 4,667	\$ 5,333	\$ 10,000
Subcontractor 3 (Robert Schmitt)	\$ 1,000	\$ 2,000	\$ 1,000	\$ 1,500	\$ 1,000	\$ 2,000	\$ 3,667	\$ 4,833	\$ 8,500
Subtotal	\$ 3,700	\$ 12,100	\$ 10,800	\$ 8,025	\$ 6,040	\$ 7,400	\$ 23,000	\$ 25,065	\$ 48,065
Other Direct Costs									
Item 1 (FWD Testing)			\$ 10,000				\$ 6,667	\$ 3,333	\$ 10,000
Item 2							\$ -	\$ -	\$ -
Item 3							\$ -	\$ -	\$ -
Subtotal	\$ -	\$ -	\$ 10,000	\$ -	\$ -	\$ -	\$ 6,667	\$3,333	\$ 10,000
Materials & Supplies (List all items over \$1000 seperately)									
Item 1: Field Testing Gear			\$ 480				\$ 320	\$ 160	\$ 480
Item 2: Miscellenious							\$ -	\$ -	\$ -
Item 3							\$ -	\$ -	\$ -
Subtotal	\$ -	\$ -	\$ 480	\$ -	\$ -	\$ -	\$ 320	\$ 160	\$ 480
Travel (State number of trips and estimated cost/trip)									
Travel to 5 field projects			\$ 5,000				\$ 3,333	\$ 1,667	\$ 5,000
Travel to WHRP Meetings (2 meetings)				\$ 400		\$ 400	\$ -	\$ 800	\$ 800
							\$ -	\$ -	\$ -
Subtotal	\$ -	\$ -	\$ 5,000	\$ 400	\$ -	\$ 400	\$ 3,333	\$ 2,467	\$ 5,800
Communications (Printing is required)									
Printing (8 printed final reports are required)						\$ 252	\$ -	\$ 252	\$ 252
Other							\$ -	\$ -	\$ -
Subtotal	\$ -	\$ -	\$ -	\$ -	\$ -	\$ 252	\$ -	\$ 252	\$ 252
TOTAL DIRECT COSTS	\$ 5,501	\$ 17,831	\$ 32,188	\$ 12,083	\$ 11,166	\$ 11,006	\$46,760	\$43,016	\$ 89,775
MODIFIED DIRECT COSTS	\$ 5,501	\$ 17,831	\$ 32,188	\$ 12,083	\$ 11,166	\$ 6,441	\$46,760	\$38,451	\$ 85,210
TOTAL INDIRECT COSTS (12%)	\$ 660	\$ 2,140	\$ 3,863	\$ 1,450	\$ 1,340	\$ 773	\$ 5,611	\$ 4,614	\$ 10,225
Fixed Fee if Applicable									\$ -
TOTAL CONTRACT COST	\$ 6,161	\$ 19,970	\$ 36,050	\$ 13,533	\$ 12,506	\$ 11,779	\$ 52,371	\$ 47,630	\$ 100,000

NOTES: *Year 1 starts with the date of the contract and ends September 30th of the following year and is based on the federal fiscal year.

Qualifications

Name and Affiliation (1)	Research Position and Role (2)	Address/Phone/Email (3)
Ahmed Faheem, Ph.D. Temple University	<i>Principal Investigator</i> Lead and coordinate the research team, guidance on all technical activities.	520 Engineering Building 1947 North 12th St. Philadelphia, Pennsylvania Tel: 215-204-6348 afaheem@temple.edu
Hani Titi, Ph.D., P.E. University of Wisconsin – Milwaukee	<i>Co- Principal Investigator</i> Lead and coordinate the research team, guidance on all technical activities.	P.O. Box 784 Milwaukee, WI (414) 229-6893 hanititi@uwm.edu
Scot Schwandt The Transtec Group	<i>Consultant</i> Develop database, data analysis, project identification and selection.	6111 Balcones Drive Austin, TX 78731 (512) 451-6233 Schwandt@TheTranstecGroup.com
Robert L. Schmitt, P.E., Ph.D. University of Wisconsin - Platteville	<i>Consultant</i> Develop database, merge different databases. Data Analysis	1 University Plaza Platteville, WI 53818 (608) 342-1239 (608) 342-1566 fax schmitro@uwplatt.edu

Dr. Ahmed Faheem, (PI)

Dr. Faheem is an assistant professor at the Temple University. Dr. Faheem has experience in managing and conducting scientific research studies for ten years. He has conducted many research projects sponsored by the Federal, and State governments as well as private industry. His research interests span through a wide range of Asphalt pavement related topics. Dr. Faheem published his work in national and international journals. He presented his work in many conferences and invited to speak in many events. Dr. Faheem is a member of a number of national and international committees, and a reviewer of prestigious scientific journals. He conducted many research studies on asphalt binder, mastic, and mixture performance, and modeling.

Dr. Faheem is experienced in flexible pavements material and construction. He is a member of the research team involved in the ongoing project NCHRP project 9-49A to evaluate the performance of warm mix asphalt (WMA) technologies with respect to long-term field performance. Work on this project involves real time monitoring of the construction of multiple test sections. This project focuses on documenting changes in construction practices for WMA, and conducting non-destructive testing for quality assurance. The test sections are then monitored for few years to evaluate the long term performance in light of the findings of the onsite monitoring and testing.

Hani Titi, PhD, PE (Co-PI)

Associate Professor in the Department of Civil Engineering and Mechanics at UW-Milwaukee and is a registered Professional Engineer. Dr. Titi has more than 20 years of experience in advanced experimental research and analysis, especially in problems related to pavement materials and geotechnical engineering. During his current position at UW-Milwaukee and previous position Louisiana Transportation Research Center and Louisiana Department of Transportation and Development, he conducted advanced research and served as PI and Co-PI for projects funded by different entities including: Wisconsin Highway Research Program (WHRP)/Wisconsin Department of Transportation, Minnesota Department of Transportation, Midwest Regional University Transportation Center, and Louisiana Department of Transportation and Development. The following are selected projects completed by Dr. Titi:

1. *Base Compaction Specification Feasibility Analysis*, Wisconsin Highway Research Program, Wisconsin Department of Transportation SPR # 0092-11-02. PI: Titi, Project Budget: \$106,936. (Completed).
2. *Phase II Investigation of Testing Methods to Determine Long Term Durability of Various Types of Wisconsin Aggregate Resources*, Highway Research Program, Wisconsin Department of Transportation SPR # 0092-10-08. PI: Tabatabai, Project Budget: \$59,991 (Completed)
3. *Characterization of Unbound Materials for ME Pavement Design of Marquette Interchange*, the Midwest Regional University Transportation Center through Marquette University, PI: Titi, Project Budget: \$14,977. (Completed).
4. *The Effect of Minnesota Aggregates on Rapid Chloride Permeability Tests*. Minnesota Department of Transportation (\$65,769). PI: Titi (Completed).
5. *Determination of Typical Resilient Modulus Values for Selected Soils Representative of the Soils Distributions of Wisconsin*. Wisconsin Department of Transportation, Wisconsin Highway Research Program, (\$103,049). PI: Titi (Completed).

Dr. Titi is a member of TRB committees (AFS20, and AFS30), a member of NCHRP panel D2431, and the Secretary of the ASCE-Geo-Institute Pavement Engineering Committee. Dr. Titi is the author and co-author of more than 70 publications (journal, conference and research reports) in the area of geotechnical and pavement engineering.

Scot Schwandt, P.E. (Consultant)

Mr. Scot Schwandt is a registered Professional Engineer in the state of Wisconsin and a Project Manager for The Transtec Group. The Transtec Group is a nationally recognized pavement engineering firm with vast experience in pavement research, pavement construction innovation techniques and pavement engineering software development

including ProVAL® and Veda®. Scot's career consists of over 25 years of Civil Engineering-Transportation work experience in several positions including: Executive Director & Director of Engineering for the Wisconsin Asphalt Pavement Association (WAPA), Pavement Structural Design/Pavement Management Engineer for WisDOT and Bridge Design Engineer for WisDOT. Scot has been very active participating on national asphalt pavement committees and has a vast asphalt pavement related professional networking resource.

Skills that Scot brings to this research team include; WisDOT database knowledge, WisDOT specification implementation practice, pavement management modeling experience, pavement design experience, FWD forensic engineering experience, and pavement construction management experience. Serving on WisDOT's WHP Steering Committee, FLEX TOC, HTCP Steering Committee and HMA Tech Team, he is very knowledgeable of WisDOT specifications, construction practices and research direction and implementation. As a private consultant, Scot has assisted WisDOT with Implements of Husbandry (IoH) studies.

Academically Scot is currently working on finishing a Ph.D. in Construction Materials with Dr. Hussain Bahia at the University of Wisconsin-Madison.

Dr. Robert L. Schmitt, P.E. (Consultant)

Dr. Robert Schmitt is a Professor of Civil and Environmental Engineering at the University of Wisconsin – Platteville. Dr. Schmitt has 25 years of combined industry and research experience and has participated in numerous transportation-related research projects sponsored by the FHWA, WisDOT, InDOT, WHP, and NCHRP. He is a registered professional engineer in the state of Wisconsin.

Related to this study, Dr. Schmitt is currently PI for a WHP study evaluating non-destructive methods for asphalt pavement compaction. Non-destructive methods are proposed for this study, including GPR and the FWD. Dr. Schmitt was a consultant to Marquette University on the first phase of *Implementation of the Mechanistic-Empirical Pavement Design Guide in Wisconsin - Phase II*, to integrate databases and develop pavement performance models. Similar to the MEDPG calibration study, Dr. Schmitt will assemble a holistic database for determining flexible pavement performance on rubblized base to identify projects for field evaluation. Dr. Schmitt was PI for MRUTC study, *Database Development for a Hot-Mix Asphalt Pavement Performance Analysis System*, that integrated multiple databases. With respect to FWD analysis, Dr. Schmitt was PI for WHP Project *Performance Evaluation of Open Graded Base Course with Doweled and Non-doweled Transverse Joints*. He is familiar with FWD testing and back-calculation and forward-calculation procedures to determine modulus.

Dr. Schmitt has published over 80 papers related to highway pavements. Specifically for this project, Dr. Schmitt will assist Drs. Titi and Faheem with the Phase I laboratory and field work plan, and with Phase II field evaluation. He will develop a holistic database, develop a field evaluation plan, synthesize the data, and write the interim and final report.

Other Commitments of Research Team

Table 2 Research Team Time Commitments

Research Team Commitments		Percentage of Time	
Team Member	Role	Committed	Available
Ahmed Faheem	PI	75%	25% to 50%
Hani Titi	Co-PI	25%	25% to 50%
Scot Schwandt	Consultant	80%	20%
Robert Schmitt	Consultant	60%	40%

Facilities and Information Services

Office space, computers, and vehicles for data collection are the primary resources necessary to conduct the research. Temple University has computers and a wide variety of software for data management and analysis. In addition, the CEE department owns field safety gear of reflective vests and hard hats.

The University of Wisconsin – Milwaukee The library has extensive collections of periodicals, literature, and related books. Materials that are not available in the UWM Library can be obtained through its Interlibrary Loan department. In addition, the

PI has access to the information retrieval files of technical literature abstracts such as TRIS and ASCE engineering database.

WisDOT/TOC Contribution

Access to pavement surface distress photologs using the RoadviewTM software to provide electronic review and data capture of pavement segments. The research team will coordinate with the Pavement Management Unit of WisDOT to access the data without disruption to routine WisDOT activities using the software. Up to 10 hours (combined) of various WisDOT staff members time for answering research team's questionnaires/in-person meetings. Up to 20 hours for providing electronic mix designs and QMP data to the research team.

References

- Hughes, C.S., Moulthrop, J.S., Tayabji, S., Weed, R.M., and Burati, J.L. (2011). "Guidelines for Quality-Related Pay Adjustment Factors for Pavements", National Cooperative Highway Research Program Project 10-79, Washington, DC, December 2011.
- Hughes, C.S. (2005). "State Construction Quality Assurance Programs: A Synthesis of Highway Practice", National Cooperative Highway Research Program Synthesis 346, Washington, DC, 2005.
- Samuel, Allan, and Jedidiah Young (2013), "Independent Data for Quality-Management Design", ASCE Journal of Leadership and Management in Engineering, October 2013, pp. 265-274.